

**Center for In Situ Exploration and Sample Return**

# **Environmental Challenges for Next Generation Exploration Missions**

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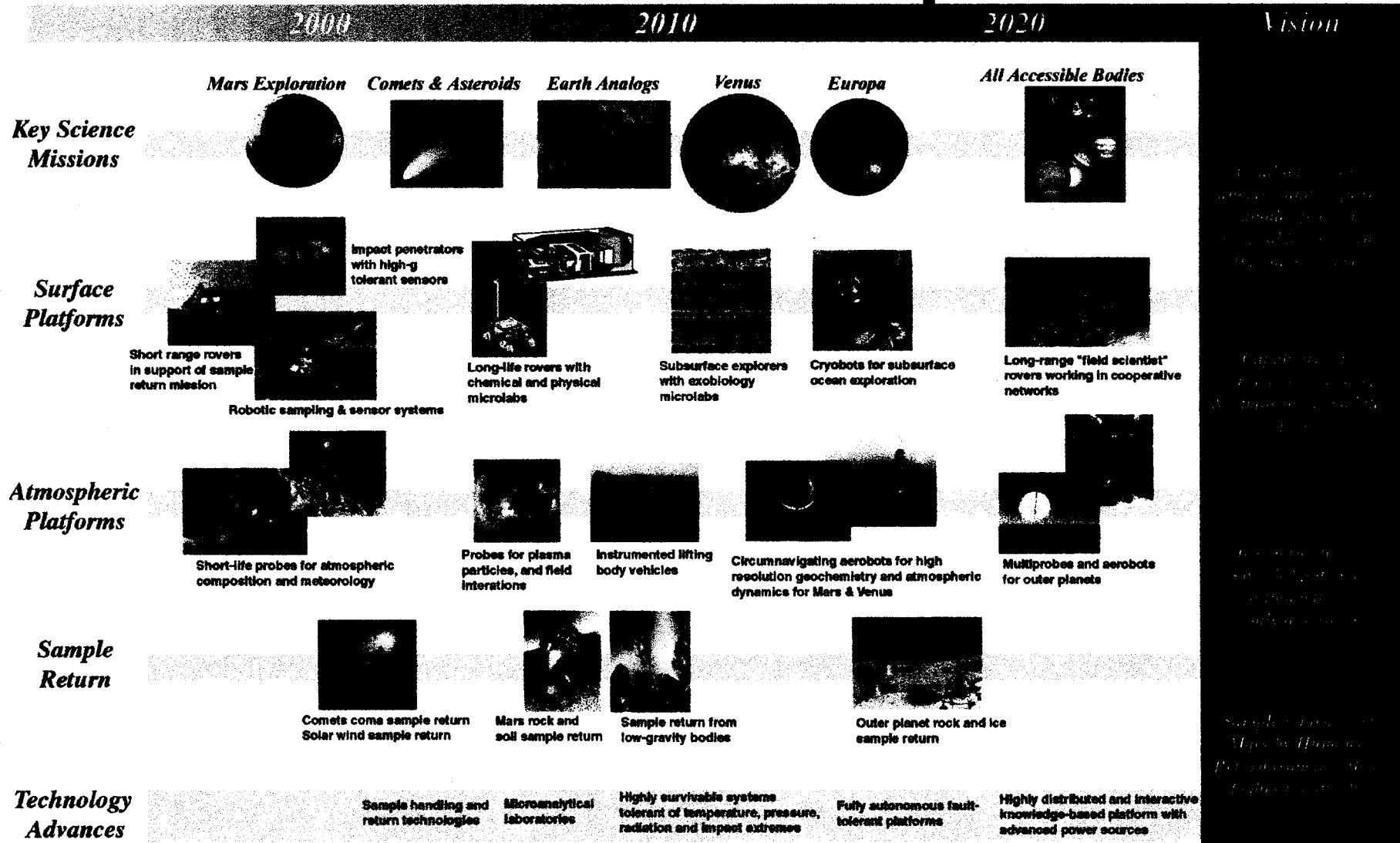
**Pasadena, California**

## **Environmental Challenges**

# **Challenges and Objectives**

- **What are the missions that provide these challenges?**
- **What are the expected environments?**
- **The challenge is to successfully take scientific measurements in there environments**
  - **Initially for a few weeks**
  - **Converting to “continuous presence”**
  - **Where should we test or before deploying landers?**

# Environmental Challenges CISSR Roadmap



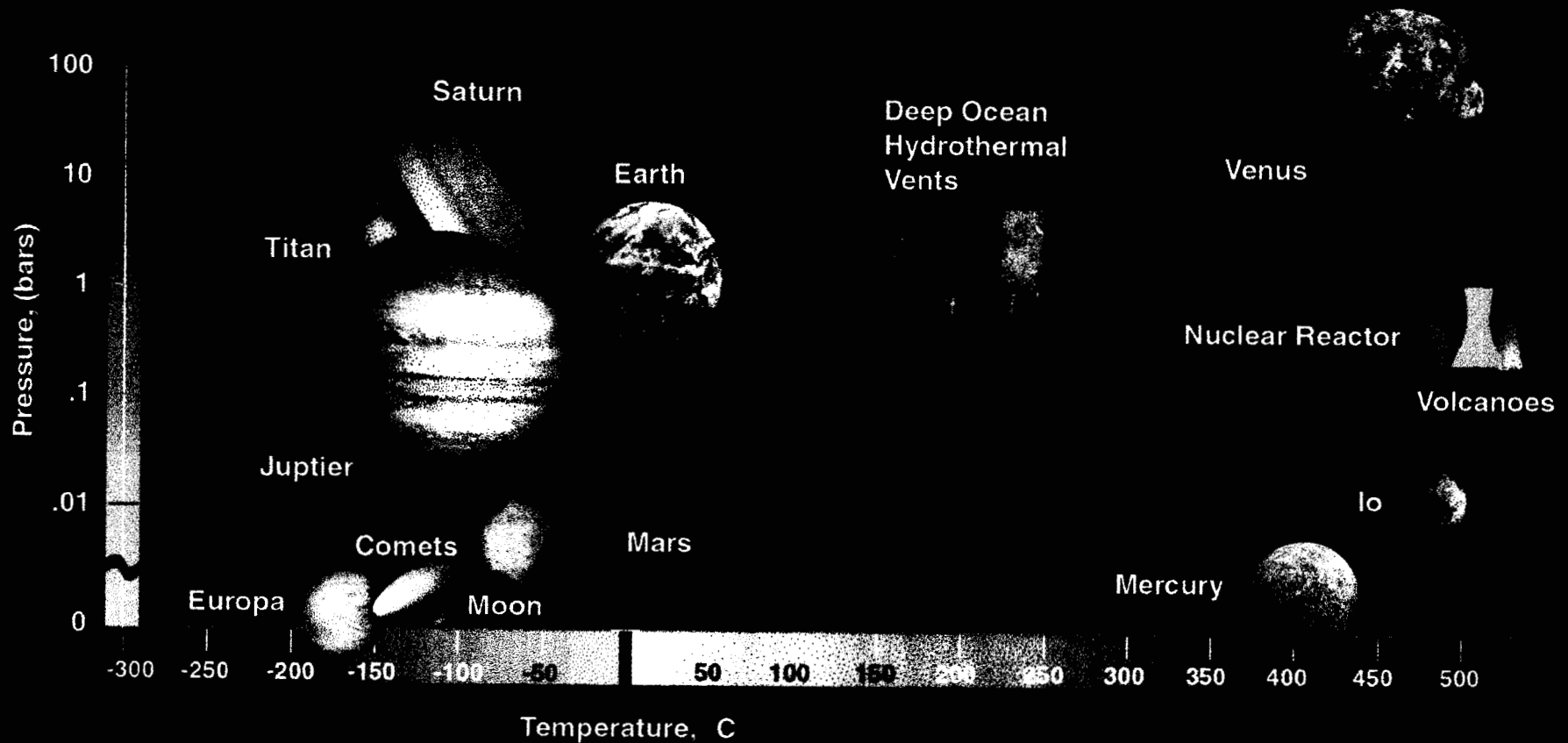
For updates, please contact William Hoffman at: [william.hoffman@jpl.nasa.gov](mailto:william.hoffman@jpl.nasa.gov)

# Environmental Challenges

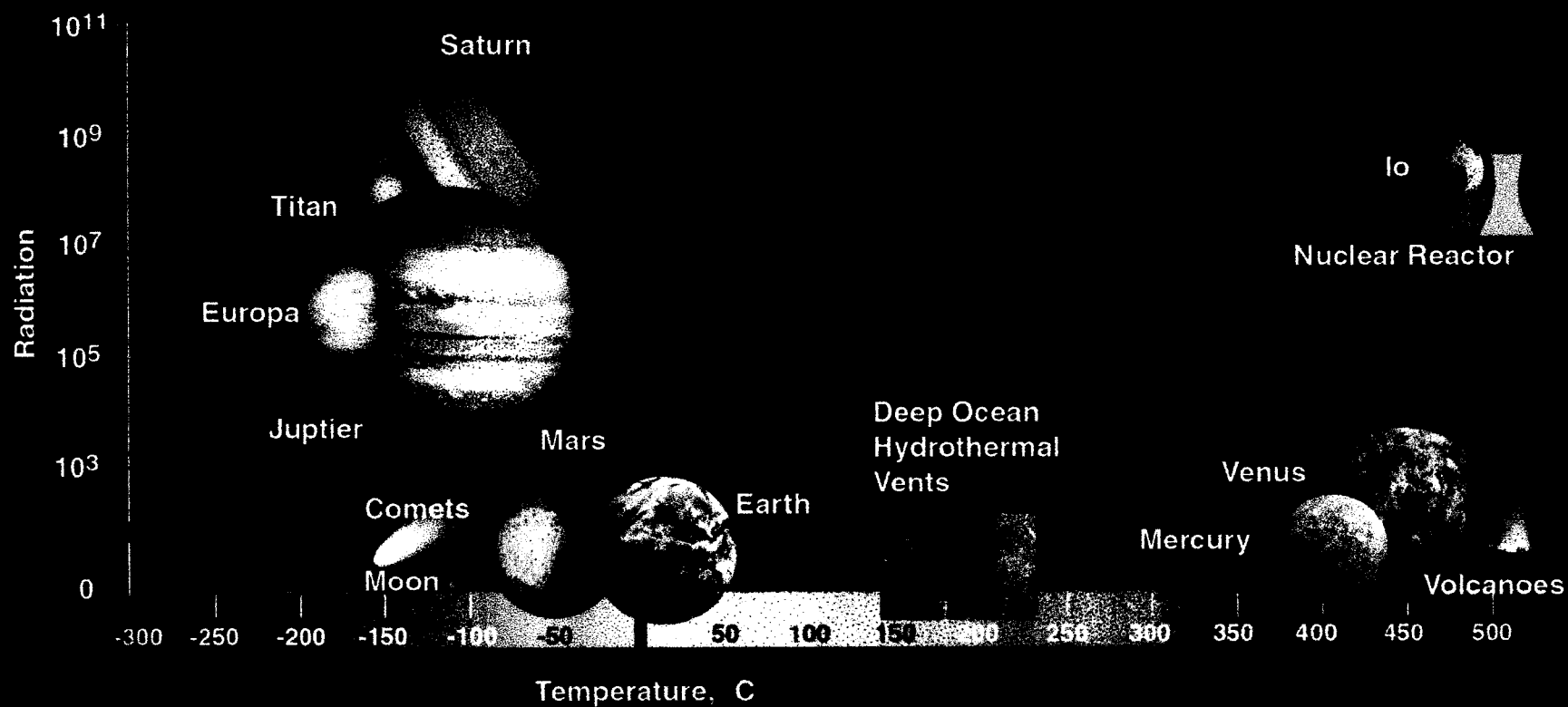
- Flyby and Orbiter missions must be designed for vacuum and solar/planetary radiation
- *But*, new *In Situ* or *Sample Return* missions face a different challenge with each destination
- Many different environments:
  - Some Extreme . . . . .
  - All variable - weather . . .
  - Plus the issues of getting in and out of planetary gravity wells

# Environmental Challenges

## Planetary Extremes

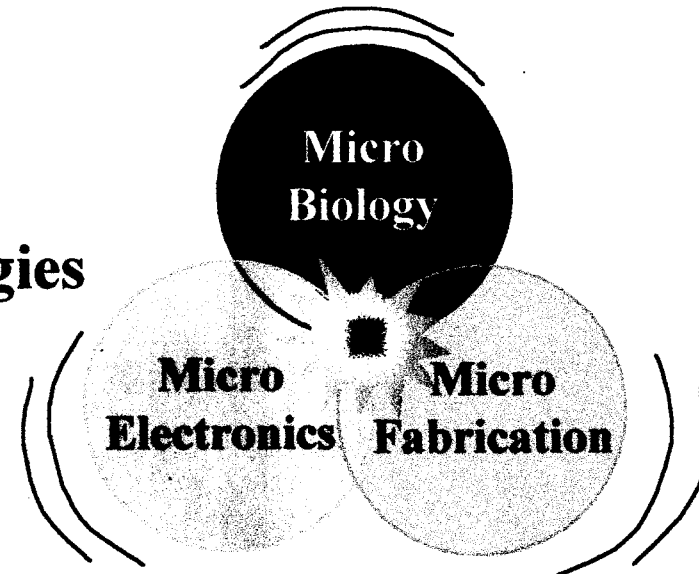


# Environmental Challenges Planetary Extremes

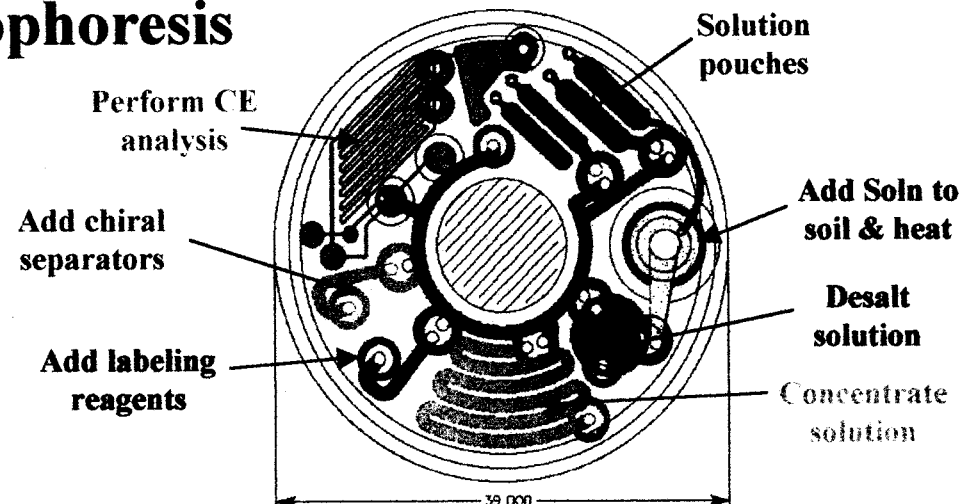


# Environmental Challenges What will we measure?

- Integrate emerging technologies



- Micro-capillary eletrophoresis  
chiral analysis



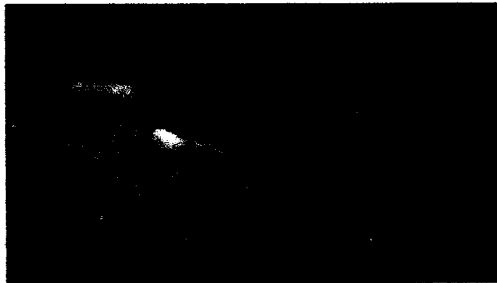
# Environmental Challenges The Astrobiology Connection

**Need coordinated suites of micro-laboratories to characterize solar system bodies and enable the search for life beyond earth**

## Looking for life

### STRUCTURE

Unexpected  
shapes or  
organization



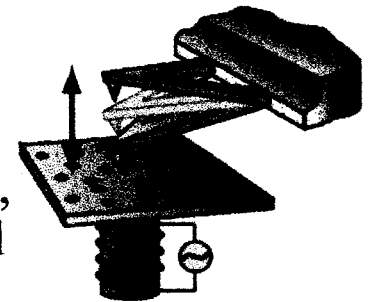
### CHEMISTRY

Complex molecules  
High-energy molecules  
Elemental or isotopic excess  
Association of chemistry  
with structure



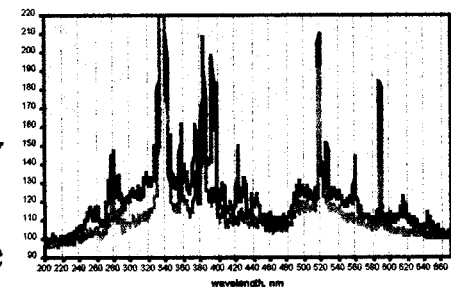
### APPROACH

Develop analytical  
tools to solve biological,  
chemical and geological  
questions



*Conduct tiered exploration in atmospheres,  
lithospheres, hydrospheres*

- Move from broad to specific
- Low resolution to high resolution
- Non invasive to successively more invasive



# Environmental Challenges In Situ Geochronology Instrument

## Scientific Goals of Instrument

- 1 Preselect samples for return from the surface of Mars
- 1 Calibrate Martian cratering record
- 1 Elucidate history of volcanism and Mars surface processes
- 1 Element ratios required to 6% or better; isotopic ratios to 0.1%

## Measurements Made by Instrument

- 1 For at least two minerals in a rock, the isotopic ratio of  $^{87}\text{Sr}$  to  $^{86}\text{Sr}$
- 1 For the same two (or more) minerals, the ratio of Rb to Sr

## Instrument Description

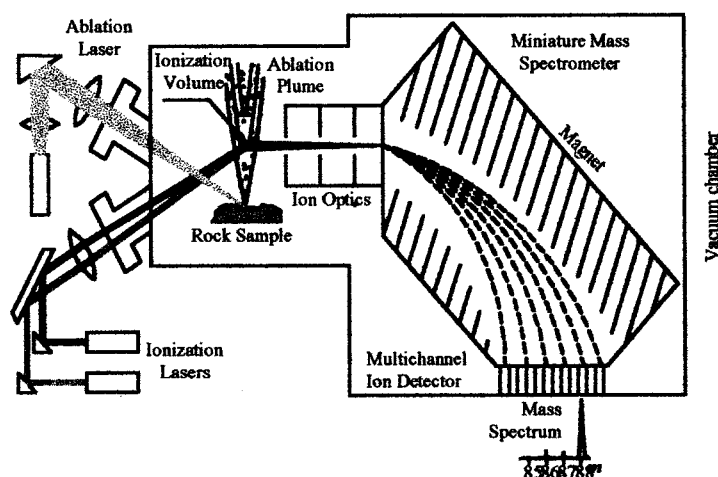
- 1 Laser ablation sampling of rock sample surface
- 1 Selective ionization of Rb and Sr
- 1 Measurement of ion beam in sector-type miniature mass spectrometer

## Development Status

- 1 Experiments to optimize laser ablation parameters in progress
- 1 Experiments in progress to develop Rb-Sr selective ionization techniques suitable for in situ instrument
- 1 JPL effort to develop in situ ablation laser suitable for instrument deployment

## Ready for Flight Development in 2003

**Profile**      Mass: 4 kg    Power: 0.5 W    Volume: 2000 cm<sup>3</sup>



# Environmental Challenges Miniature Iron-Nuclear Magnetic Resonance ( $^{57}\text{Fe}$ -NMR) Spectrometer

## Scientific Goals of Instrument

- 1 Characterization of magnetic phase minerals in Martian soil, rock samples

## Measurements Made by Instrument

- 1 Detection of Hematite, Magnetite from soil, mineral samples
- 1 Sensitivity 0.1 wt%

## Instrument Description

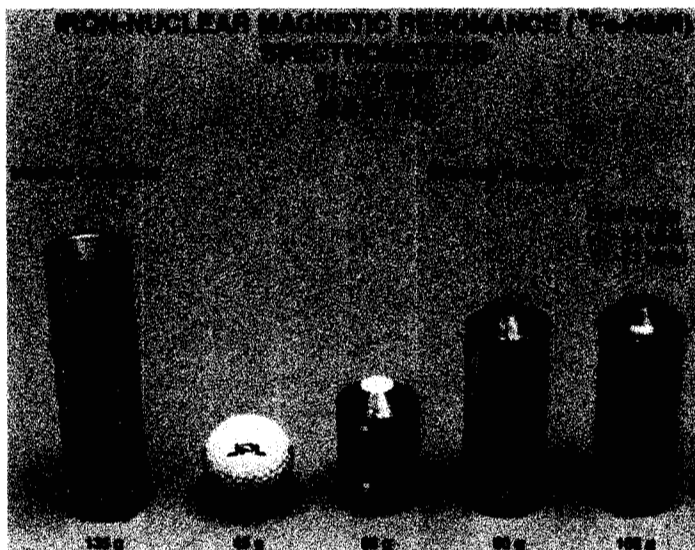
- 1 Detection of magnetic phase minerals through interaction of iron nuclear spins with unique Internal magnetic field of sample
- 1 Consists of a radio frequency coil, continuous wave NMR circuit (marginal oscillator), digital signal processing circuit
- 1 Sample size: 1-2 cc

## Development Status

- 1 Field tested in Lavic Lake, Mojave Desert with Rocky-7 in May 1997

Ready for Flight Development? ☐ now ☒ '03 ☐ '05 ☐ >'07

Profile    Mass: 60 gm    Power: 0.25 W    Volume: 60 cm<sup>3</sup>



# Environmental Challenges Learning to Study in Extreme Environments

	<b>Lo'ihi</b>	<b>NEPTUNE</b>	<b>Vostok</b>	<b>Europa</b>
<b>Instruments &amp; Sensors</b>	Biological Geological Chemical	Robust Long duration	Highly Integrated	Interactive
<b>Robots</b>		Autonomous service vehicles	Vehicles with vision	Robust miniature robots
<b>Communications</b>	Real-time data processing and analysis	Underwater communications	Through ice	Through water and ice
<b>Packaging/ Materials</b>	Packaging of sensors and electronics for extreme environment	Corrosion resistant materials High pressure	Packaging for operations in ice and water ice	Rad hard Corrosion resistant materials
<b>Navigation</b>		Precision three dimensional wide area acoustics system	Precision ice and water navigation Ice penetrators	Navigate within thick-ice Ice penetrators
<b>Contamination</b>		Sterilized systems	Biologically, chemically clean systems	Sophisticated planetary protection

## **Environmental Challenges Summary**

- **New technologies will be key to success just as they were in the past for remote sensing missions**
- **We need to leverage others investments to make these new missions affordable**
- **This is as big a step as going into space was 30 years ago .....**

## Acknowledgement

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